NOVEMBER 1, 1919

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AVIATION AND AERONAUTICAL ENGINEERING

Start of the Army-Navy Championship Balloon Race at St. Louis, Mo.

Wide World Photos

VOLUME VII
Number 7

Three Dollars a Year

SPECIAL FEATURES

CHARACTERISTICS OF PURSUIT AND RECONNAISSANCE AIRPLANES
VOUGHT FLYING BOAT VE-10
CURTISS EAGLE TRANSPORT AIRPLANE
AIRPLANE DEMAND AND THE ART OF KILN DRYING
IMPORTANCE OF PIGMENTED COVERINGS

PUBLISHED SEMI-MONTHLY
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CREW OF U. S. MARTIN "ROUND THE RIM FLYER"—Left to right: Colonel Hartz, Lieuts. L. A. Smith and E. E. Harmon, Sergeants John Harding, Jr., and Jeremiah Tobias

Martin Bomber No. 2 has been in constant use for a year at Bolling Field, Washington, D. C. With more than 10,400 miles of cross country work already to its credit, this plane was started off on an 8,000 mile flight around the rim of the United States, in command of Col. R. S. Hartz. The colonel and his crew of four have just completed their unparalleled pioneering trip.

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FROM	TO	PILOT	DISTANCE	MARTIN AIRPLANE TIME	RAILROAD TIME
Cleveland	Dayton	Eric Springer	215 Miles	1 hour, 30 min.	5 hours
Washington	New York	Capt. Francis	285 Miles	2 hours	5 hours 15 min.
Cleveland	Washington	Eric Springer	350 Miles	2 hours, 58 min.	14 hours
Cleveland	New York	Eric Springer	450 Miles	3 hours, 20 min.	14 hours
Dayton	New York	Capt. Francis	635 Miles	5 hours, 40 min.	18 hours
Macon	Washington	Capt. Francis	630 Miles	6 hours, 15 min.	21 hours

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Long Island City, New York

NOVEMBER 1, 1919

AVIATION AND AERONAUTICAL ENGINEERING

VOL. VII. NO. 7

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AVIATION AND AERONAUTICAL ENGINEERING

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Vol VII November 1, 1919 No. 7

THE Air Mail Service has just issued a record of forced landings for the six month period ending in November, which makes very interesting reading. For each forced landing 8,988 miles were flown, which is quite a respectable figure, and certainly one which the automobile cannot even approach as regards breakdowns.

The principal causes of breakdown were: oil pressure, 7; radiator, 4; gas pressure, 3; plugs fouling, 3; ignition, due to rain, 2; carburetor, 3; connecting rods, 2; other causes, 1 each of the following; gas leak, distributor fouled, water line leak, generator trouble, piston ring broken, gas lead clogged, oil lead broken, distributor head cracked, spark plugs worked loose.

No plane failures occurred. It would seem as if the engine designer were the one man to blame for forced landings, hence greater reliability in operation will only come with improved engines.

Extension of the Monoplane Principle

In the Zeppelin Landau flying boat, we have a very interesting extension of the monoplane principle. Although equipped with four 260 h. p. motors and having a span of over 100 feet, fuel for 70 hr. and complete armament and instrument equipment, the flying boat is a monoplane with top and bottom wire trussing. The single float under the wings may be better termed a flying boat. The fuselage which carries the tail surfaces is placed above the wings and serves for the attachment of the landing wire bracing. The total weight is twelve tons.

This machine, sometimes mistakenly called the Dornier seaplane, seems to discredit strongly the general belief that monoplanes can only be built successfully in small sizes, and therefore the construction of the Zeppelin company along these lines will be watched with interest.

The Variable Pitch Propeller

While the variable pitch propeller seems to offer practical possibilities both in the United States and abroad, it will always be viewed with a certain amount of prejudice by both the aeronautical engineer and the flier, who dread the introduction of any additional mechanism, however simple and mechanical it may appear to be.

It is interesting to note in this regard that the French are considering another solution of the variable pitch propeller. A well-known designer proposes to have two two-bladed airscrews, one for getting off and climbing to 15,000 feet and the other for operating above that height. The altitude screw will be free during the first part of the climb and be brought into action by a special clutch, thus converting the two-bladed screw into a four-bladed one at will.

Collapsible Floats

The first published description of collapsible floats has appeared in a recent issue of *L'Aérophile*, this being another interesting war development which the censor has so long kept in obscurity.

Two or more floats of rubberized fabric are rolled up and stowed under the wings or under the fuselage, and these can be filled by means of a compressed air apparatus in thirty seconds. The number of bottles of compressed air required is reduced considerably by the addition of an injector which draws in external air.

The wheels of the chassis may in some cases be dropped off before alighting on the sea. In addition a hydrovane is fitted in front of the chassis to prevent too great a shock to the inflated floats on alighting.

These air bag floats have considerable possibilities for ship airplanes, allowing land machines to be used in lieu of seaplanes, which of course are much less speedy for the same power. They may also have possibilities in commercial single-engine land machines flying over country with large stretches of water.

Thermo Dynamic Efficiency

There is perfect agreement among engineers that with heat lost in the water-jacket and in the hot exhaust gases an enormous amount of energy is wasted in the internal combustion engine. Furthermore it is beyond doubt that all prime movers are as perfect as we can make them from a mechanical efficiency point of view. But, in spite of all this, very little has been done of late towards improving the thermodynamic efficiency of the internal combustion engine.

Now we hear of an engine operated on a principle which promises to give most valuable results. This is the Still engine, recently described in a number of English technical publications. It is a combined steam and internal combustion engine using any orthodox fuel, liquid or gaseous, with steam only as a subsidiary.

An overall efficiency of 33 per cent is claimed for the engine as compared with about 25 per cent for an ordinary aeronautical engine.

The two main sources of waste mentioned above have been attacked in a masterful manner. The cooling water in the cylinder is maintained at a much higher temperature, and is connected to a series of tubes, which the exhaust gases contrive to heat. In conjunction with a regular boiler, a very workable arrangement is obtained.

No aeronautical engineer, however specialized he may be, can fail to note this important development.

Comparative Averages of Characteristics for Several Pursuit and Reconnaissance Airplanes

By Randolph Hall

The following average figures have been based upon a number of type airplanes used in the war, namely—American DH-4, Breguet 14 A2, Salmson 2-A-2, AR2, Sopwith 1-A2, Sop Camel F 1, Spad VII, Spad XI, Spad XIII, Nieuport 28 and SE-5.

The above planes have been divided into two classes, one place pursuit types and biplace reconnaissance. The latter class included the first five mentioned and the Spad XI, while the remainder constitute the former. In several instances it has been necessary to make a distinction between the heavier

Fig. 1 Bréguet 14A-2 Bomber-Reconnaissance Plane

and lighter reconnaissance types, as, for example, Bréguet's and Sopwith 1-A2's may be classed as heavy and light biplace reconnaissance airplanes, respectively.

The information has been obtained from actual performances and measurements taken from planes furnished the U. S. air service in France. The matter is treated thoroughly by the writer in a comparative report on airplanes based upon types at Orly Field, compiled at the Inspection Section there, and made to the Technical Office in Paris.

General Performances

The maximum speed for pursuit airplanes averages from 120 to 145 m.p.h. One hundred and ten miles is a normal figure for the reconnaissance type. The minimum speed figures

Fig. 2. AR-2 Light Reconnaissance Plane

are not available, but they are rather high. Climb for the former is 10,000 ft. in approximately 9 min., and for the latter 10,000 ft. in 10.5 to 11.5 min. This is taken with full load.

Load

The percentage of the total useful load (sum P. C. and P. U.) to the total weight fully loaded averages 31.5 per cent for the pursuit type and 37.3 per cent for the reconnaissance type. Fuel load (P. C.) as a percentage of total load; total useful load is equal to 42.5 per cent and 36.5 per cent for the two classes.

Note. In subdividing the total useful load into the weight of fuel (P. C.) and the weight of occupants, ammunition, equipment, etc. (P. U.), an allowance can be made before flight for added P. U. if the tanks are not full. Most foreign planes give the values of P. C. and P. U. on their rudder.

Load per sq. ft. for the one place averages 8.2 lb. and 6.8 lb. for the two place. Per horsepower it averages 9.0 and 12.3 lb.

Duration, Hour's Flight

This averages two hours for the pursuit and little over three hours for the reconnaissance airplanes.

Fig. 3 Salmson 2A-2 Light Reconnaissance Plane

Gun Mounting

Synchronized machine guns, synchronizing mechanism directly operated by the engine, are mounted above or on the side to the rear of the motor. As in the case of Sopwith 1 A2 and A. R. L. Type E, machine guns are sometimes mounted above the upper plane. One or two machine guns are mounted on the gun ring for the observer.

Aspect Ratio

Averaging both planes, top and bottom, this is from 5.92 to 7.7, 6.85 the average for the two-seater. The pursuit machine for structural reasons, in spite of high efficiency, has a lower ratio of 5.34 to 7 with 5.93 as the average.

Gap in per cent of chord seems to be about the same, or, if

Fig. 4. Sopwith 1A-2 Light Reconnaissance Plane

anything, slightly greater for the reconnaissance type. No direct comparison can be made for the pursuit types. Spad 13 is 82 per cent, Nieuport XXVIII 107.5 per cent, SE-5 is 92 per cent and Sopwith Camel averages 103 per cent.

Rake

The rake at wingtips depends chiefly upon the designer. For types considered, it varied from 0 to 25 deg.; that is, the wingtips are either practically square, as in the case of Spad types, or more usually, extending out towards the rear to increase the aileron surface and give it a greater lever arm. The extremity of Nieuport 28 is oval-shaped.

Overhang

Practice often favors a slight overhang, but seldom to an extent to require additional trussing.

Control Surfaces

This also depends upon the general design. An effort has been made to express the surface as the average product of the control surface total area in square feet, and the lever arm from the control surface center of pressure to the center of gravity of airplane approximately determined in feet. Areas are to a great extent dependent upon the weight. The heavy two-seater types considered averaged close to 3,300 lb. and the lighter type of the Sopwith 1-A2 class averaged 2,200 lb. Expressed for the elevators of the heavy type, this is 780 feet^3, and for the lighter biplace, 372 feet^3. The figure for the one place is 164 feet^3. Expressed for the ailerons this is 1,025 and 625 feet^3 for the biplace types and 198 for the one place.

Fig. 5 Nieuport 28 Pursuit Plane

Reconnaissance (biplace) rudder areas average 15.7 and 8.3 sq. ft., while the pursuit is only 6.45 sq. ft.

The elevator surface averages approximately 86 per cent of the stabilizer surface for both pursuit and reconnaissance airplanes. However, Salmson and AR-2's have no stabilizer, and although the surface is greater than the average elevator surface, it is interesting to note that their surface is practically the same as the Breguet elevator's attached to a stabilizer.

Aileron Droop

When cable is used throughout the reconnaissance, aileron droop averages .046 inches per sq. ft. of surface and as the majority of pursuit planes are more mechanically operated (that is, without leads), due allowance must be made for their respective controls.

Wing and Stabilizer Setting

Airplanes considered, with the exception of Spads, have a dihedral setting of at least for one of the planes. This generally ranges from 2 to 5 deg. English designers seem to prefer more dihedral than the French.

Incidence is dependent upon the wing section and data pertaining to the latter is lacking. Not considering the 5 deg. incidence of the SE-5, pursuit planes have less incidence than the reconnaissance, ranging from 45 min. to 2 deg. against the others 2 to 3 deg. incidence. Wash in allowance of a fraction of a degree is usually made at an outer strut to compensate for the propeller torque.

Stabilizer settings for American DH-4, SE-5 and Sopwith 1-A2 is adjustable from the seat, but positive under the normal flight conditions.

Breguets and Sop Camels are also positive, but Spads VII and XIII are slightly negative.

A reverse stagger is required for Breguets and A. R's. Salmsons have none and the others vary from an unnoticeable stagger for Spads pursuits, to two feet.

Tolerances

Wing setting tolerances should be confined within small limits. Owing to the extent and repetition of errors under present conditions, a tolerance of plus or minus ⅜ in. has been allowed for incidence readings. However, this error must not be confined locally, but maintained within limits of plus or minus ⅛ in. throughout.

Wash in tolerances of plus 5/32 in. or minus 3/32 in. (vice versa for wash out) is made over the actual setting. Limits for stagger have been plus or minus $\frac{3}{16}$ in. Tolerance allowed for diagonal check measurements from rudder post to wing outer strut is ⅝ in. Propeller diagonal check measurement and propeller track measurement allow a ¼-in. tolerance. An increase of 15-in. dihedral may be tolerated for the wings provided they still remain symmetrical to the fuselage. There should be no negative dihedral.

Note. The above tolerances are not suggested to be used. They are based upon the condition in which planes have been received at the Inspection Section.

Fig 6. SE-5 Pursuit Plane

Fineness Ratio of Wing Struts

Designers choose their strut fineness ratio from a consideration of strength, resistance, and fin area for yawing. To simplify construction struts are made with uniform section throughout, but from a resistance and weight standpoint, tapered struts of uniform strength are desirable. Neglecting metal tube interplane struts, the maximum fineness ratio averages 3.5 for all types.

Rib Spacing

In order to preserve a more accurate wing profile for fast planes, the ribs are spaced as close as 5 in., but for the slower types, ribs have been spaced as far apart as 16¾ in. A fair average is 13¾ in.

Fabric

Both linen and silk fabric is used. It was requested that figures be given for the fabric required. This has been impossible, but from previous notes of a battle plane, pursuit and seaplane, the fabric necessary was equal to 1.70 times the sum of the normal projected areas of all sides. This included the fuselage.

Control Leads

In order to avoid stretching, piano wire seems to be preferred to cable where there are no sharp turns to contend with. Trend of design is towards more mechanical operations, for instance push and pull methods.

Cable Splices

French and Italian manufacturers prefer the cable splice to our customary soldered copper wire wrapped cable joint. A spliced cable with the end away from eye wrapped and soldered makes a secure connection.

Turnbuckle Safeties

The most accepted turnbuckle safety device is the copper wire through the barrel and twisted about both eyes. In some cases where twin bracing is used, two turnbuckles have been locked together with wires, through their barrels. A few planes have come to Inspection Section with spring brass

wires through the barrel and upper turnbuckle eye only. This method does not seem objectionable

Structural Features

There does not appear to be any exceptional structural differences between European and American built airplanes. Sheet steel metal fittings, drop forgings and castings are similarly used Duralumin has proved a worthy substitute for steel in many places.

Hinges

Very little effort has been made to eliminate resistance caused by the space between a surface and its appendage, and in course of motion these surfaces are not always in line The common example of this design is the beveled edge type which forms an open vee until the surface is moved, its maximum

Fig. 7 Spad XIII Pursuit Plane

limit in one direction. It would be very unfortunate if anything should lodge in this space. Male and female eyebolt hinges are used to a great extent. The SE5 aileron hinge has reduced resistance to a minimum.

Instruments

All types are equipped with the usual instruments for controlling the plane and aerial navigation, but no standardization exists in their arrangement upon the dash and about the cockpit

Engine Vibration

There is no excessive vibration with modern type engines In most cases the elasticity of the structure will absorb what little exists The Breguet engine rests upon eight cork blocks encased in steel boxes and bolted to engine beds. To further take up any vibration, eight slightly conical washers are used between the feet and head of each bolt

Exhaust

No difficulties from burnt gases or appreciable loss in power has resulted from the present exhaust methods. Rotary motors exhaust direct and the gases are emitted from the side or bottom of engine cowl The Salmson exhaust manifold encircles the radiator and the exhaust is at the sides. Renault Breguets exhaust over the top plane and Fiat Breguets at the nose and to the side American DH-4's, Spads and SE-5's carry their exhaust along the side to rear of pilot

Fuel Systems

Generally in starting the engines gasoline supply is furnished with a hand pump Fiat Breguets eject gas directly to their intake manifold Engine gasoline or air pressure pumps, wind mill pumps, or venturi tubes supply gas to the gravity tank. Venturi and hand gas or air pressure pump has been a common method of supplying gasoline to rotary motors.

The engine pump, or Astra, driven by a small propeller in the slip stream as the Salmson plane, furnishing gas through the gravity tank, is the system that is probably favored most. Starting is accomplished with hand pump

Engine Radiating Surface

The slow types are based upon American DH-4's, Renault and Fiat, Breguet and Salmson Spads 7 and 13 have only been considered for the fast type. The former's frontal area averages 2.60 sq. in. per horsepower, and the latter 2.48 sq. in per horsepower. Total surface averages 63 sq in and 50.68 sq. in. per horsepower for the two types.

Precautions Against Fire

As a precaution against fire the gasoline tanks are often covered with rubber and a wire mesh. This may be readily observed from the rear cockpit of the Salmson The Breguet's upper tank is covered in this manner, but the lower tank in case of fire or danger from gun fire, can be released through a trap door in the fuselage by raising a lever to the right of the pilot's seat

A number of Spad tanks have a pear-shaped patch sweated over an opening The pilot may drain the gas by pulling a wire that is attached to this patch.

Undercarriage

The heavy airplanes averaged 27.5 ins. from the wheel center to center of pressure, which was approximately determined by assuming it to be 45 per cent of chord corresponding nearly to the high speed condition. The light class averages 19.70 in The position of the wheels for DH-4's and Nieuport 28's to the center of pressure barely exceeded one-half of that for other types. Variations ranged from 15.12 to 37.80 in, for reconnaissance planes and 13.62 to 26.20 for pursuits.

Tread for biplace averages 73.25 in. and 59 in for the one place. Tires vary from Spad 25.59 x 2.55 in size to 31.5 x 5 ⅞ in. size for Breguets.

A rough estimate of maximum deflection (assuming both wheels deflect together), inclusive of tires for each 100 lb. of weight is .28 in for light and heavy types regardless of their differences in speed. Assuming this occurs under a dynamic load of 7, the axle deflection alone under dead weight is .023 in. per 100 lb

The angle made when the tail is in flying position to that when airplane skid rests upon the ground averages 13 deg for biplaces and 14 deg 30 ft. for one place.

The axle streamline is often designed to produce lift when flying

Propeller Ground Clearance

Propeller ground clearance for both types ranges from 8.86 in to 17.78, 11.5 in the average

Aviator's Remarks

The true test of any airplane is made by the pilot and his opinion regarding its flying qualities cannot be disregarded. The majority of planes supplied to the United States Government have met with approval among the fliers, but it is surprising that there is considerable disagreement as to which are the best to fly

For instance, one pilot maintained that nothing could be compared with the Salmson balanced elevator, while another insisted that it was impossible to improve upon a stabilizer with the attached elevators As far as pursuit types are concerned most American pilots favor Spads, although undoubtedly an English pilot prefers the Sop Camel. The truth of the matter is generally that a pilot prefers the plane he is most accustomed to handle. Experience is the big factor At first DH-4's were considered too nose heavy for landing Now the pilots like to fly them

The important conclusion to be drawn is that types considered have not met with disapproval and that although the pilots are most concerned with the flying qualities, it is inadvisable to rely too much upon any one pilot's opinion.

Nieuport Monoplane, with 160 Hp. Gnôme Rotary and Rigid Wing Truss, Developed Early in 1918

The Vought Flying Boat, Model VE-10

The Vought three-seater flying boat, Model VE-10, is one of the latest productions coming from the Lewis & Vought factory at Long Island City, in which was designed and built the well-known VE 7 advanced training machines of the U S. Army Air Service.

The VE-10 three-place flying-boat has proved in the many tests to which it has been subjected that it is a very remarkable and satisfactory design. It has an exceptional performance for relatively low horsepower, a high factor of safety for extremely light weight, and has incorporated in it a number of new and improved features in design and construction.

It is a pusher biplane, short-hull type, flying-boat with a 90 hp OX-5 engine, a single propeller, and a novel outrigger tail construction somewhat reminiscent of that of the Navy's famous trans-Atlantic machines. Seating accommodations are provided for a pilot and two passengers The tank capacity is sufficient for two and one-half hours' flight at full

Fig. 1 Quarter View of the Vought VE-10 Flying-Boat
Photo Lavarnick

throttle, at sea-level The normal useful load is rated 620 lb., although the machine gets off quickly and maneuvers splendidly with a useful load up to 800 lb This is equivalent to saying that the VE-10 will carry full tanks and three people whose weights are slightly in excess of 200 pounds each This feat is very unusual and it is doubtful if any water machine of equal power has ever lifted such a heavy load The climbing rate with the rated useful load is 325 ft. the first minute, and 2650 ft in 10 min The low and high speeds, at sea-level, are 46 and 80 m p h., respectively

Pilots who have flown the VE-10 claim it is one of the best balanced and easiest controlled machines they have ever handled Most of them are of the opinion that it can be maneuvered and stunted as well as the average land machine Stunting in boats has never been indulged in to any great extent because very few water machines have been capable of such maneuvers, or have had the necessary high factor of safety The VE-10 is very light on controls and in straightaway flight the stick may be entirely released, the machine actually flying itself Another excellent characteristic is that it noses over and takes its natural gliding angle when the power is shut off The gliding angle is 8 to 1.

The short hull, which is 15 ft. 8 in long and 4 ft in beam, has one ventilated step, which is separate from the bottom proper, being of the so-called false type. This type of step has many advantages in construction and maintenance. The bottom is Vee-ed from bow to stern at an angle which makes it extremely strong and permits an easy entry in landing, so much so that landing shocks are effectually absorbed. A peculiar feature of the hull is that it has none of the usual side fins. The bottom chines form the outer edges of the bottom, which makes the hull very simple to construct The VE-10 trims at one degree on the stern and planes quickly with no tendency to porpoise. The draft at the step is only 10 in. in fresh water The short hull appears to have the advantages of:

(1) getting up on the step quickly,
(2) leaving the water in a short distance,
(3) taxiing nicely, particularly in side winds,
(4) low head resistance, due to proper shape,
(5) low construction weight,
(6) not subjecting the tail unit to undue strains in landing, and
(7) of being easy to handle in and out of hangars and on beaches. Only one man is required to get the VE-10 on a beach If the tide goes out and leaves it on dry sand, the propeller thrust is sufficient to push it back in the water without manual assistance. It is questionable whether this can safely be done with the long hull type of flying-boat

The hull is constructed of oak chines, liberally gussetted oak ribs, and three-ply water proof birch veneer The veneer is imported stock and is made of material which is cut from the circumference of timbers Each ply is integral and no edgewise gluing is necessary in making up panels, this integral feature eliminates all possibility of the veneer opening up. The hull is coated with amber varnish, natural finish.

The seating arrangement is very unique in that the three seats are in the same cockpit, in the front part of the hull forward of the wings, and are arranged in clover-leaf form, with the pilot in front. Since the hull is 4 ft. in beam it is apparent that the passengers have plenty of room and are not cramped in one position. This comfort adds greatly to the pleasure of flying

The comfort and convenience of the passengers have been well considered in the design of all cockpit details. The seats and arm rests are well upholstered in black leather. Each cushion is liberally padded with Kapok and attached to the seats with quick detachable clips The cushions may be used as life preservers. In front of each passenger's seat is a neatly designed nickel plated foot rest similar to those used in motor cars Around the combing of the cockpit is a celluloid windshield which deflects the air well above the heads of the passengers One may ride in the machine with full assurance of not getting wet from spray or having one's clothing soiled with oil.

The machine is equipped with a single stick control which is standard VE-7 design It is made of steel tubing and

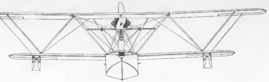


FIG. 2 FRONT ELEVATION OF THE VE-10

stamped sheet steel parts. The elevator cables are concealed in a longitudinal, horizontal member and no rocker arms of any sort are used. The aileron controls have no pulleys other than those on the wings. The controls are practically frictionless and are easily operated. All control cables pull directly in the plane of the control masts, thus neutralizing all forces tending to bend the masts sidewise. The rudder is operated with the usual VE-7 design of foot rudder bar and cables.

The throttle is operated by a system of rods and bell cranks and is absolutely positive in action. No wires or other uncertain functioning parts are used anywhere in the construction. The complete mechanism is very cleverly worked out and is remarkable for its utter simplicity.

The fuel supply system consists of a pressure tank, a supplementary hand pump, gasoline presure gauge, and a mechanically operated pump connected to the engine. The gasoline is fed directly to the carburetter. A safety pressure relief valve is part of the engine pump. The gasoline tank is cylindrical in shape and very light for its capacity. The filler base extends up through the deck of the hull, thus permitting the tank to be replenished by simply removing the filler cap. A visible fuel quantity gauge also extends up through the deck. The tank rests on two horizontal bearers

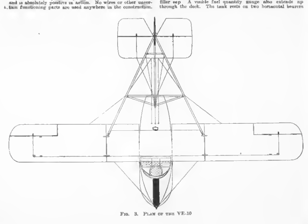


FIG. 3. PLAN OF THE VE-10

in the rear cockpit and is held in place with four swedged wires which run from clips bent over the upper rim of the tank to similar clips attached to the bearers. This installation is extremely simple and light.

From an engineering standpoint the VE-10 is a very interesting study. Besides its novel hull and many excellent details, the design has a well thought out wing cellule and outrigger tail construction, and in addition, a novel engine mounting.

The wings are composed of five panels, three uppers and two lowers. The outer panels of each wing are identical. Each panel is about 12 ft. long. Four interchangeable standing wires whatever in the bay in which the propeller revolves. The bay is braced externally with two ⅜ in. cables running to the lower wing. This is a very important refinement because it eliminates any possibility of the bracing wires becoming entangled with the propeller.

The tail surfaces consist of one adjustable horizontal stabilizer, one vertical fin, one rudder and one set of dual elevators. The tail plane is adjusted by simply changing the length of four telescoping tubes, by means of quick detachable pins, and by tightening eight swedged wires. The rudder is always out of the water and spray and endows the

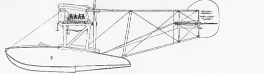


FIG. 4. SIDE ELEVATION OF THE VE-10

ardized ailerons are used for lateral control. The wing bracing is the Warren type of truss and consists of twelve struts, twelve incidence wires, and the necessary fittings. The truss gives the design a very clean appearance and evidently contributes much to the fine performance by lessened head resistance and decreased weight. The Warren truss as worked out on the VE-10 has the advantages over the Pratt truss construction of,

(1) Simplicity,
(2) Fewer parts,
(3) Low head resistance
(4) Impossibility of incorrect setting up, or mal-alignment, and
(5) Of not requiring adjustment after it is once set up.

It is claimed by the designers that the VE-10 Warren truss will show practically no depreciation, or decrease in strength after long usage.

The struts are made of selected spruce with swedged steel tension rods running through their centers fastening the strut sockets at each end. The strut sockets are made of two stampings of 1-16 in. sheet steel and the wing spar bases of one ⅛ in. sheet steel stamping. The base is held on the wing spar with two ¼ in. nickel steel bolts. The bolts and nuts are well standardized thoughout the design and very few sizes are used. The incidence stays are 0.135 in. diameter swedged steel rods with small nickel steel forbed ends for adjustment. The rods are threaded at each end, one end right hand, the other left hand thread. The fittings are very simple, durable, well standardized, and adapted to quantity production operations.

The outrigger tail consists of three wooden booms, four struts, a triangular tubular brace, the control surfaces, fourteen wires with the necessary fittings, and four short tubular adjustment struts for the horizontal stabilizer. The construction is very rigid and free from all vibration. Two men can hang on the stern post without causing any noticeable deflection. The upper booms are horizontal and in the plane of the upper wing spars. The upper booms butt against the rear engine section spar and form a triangle to the fin stern post. One fitting serves as wing strap, strut base, and outrigger connector. The lower boom is attached to the hull and is in the plane of symmetry. The booms are 2 in. outside diameter. They are made of wood and covered with linen fabric doped on and finished with gray enamel. The booms are very light; the upper ones, which are 14 ft. long, weigh only 8 lb. each with all fittings attached. There are no bracing boat with plenty of maneuverability in taxi-ing. The control surfaces are symmetrically located about the line of thrust.

The engine mounting consists of only two parts. Each support is made up of nine laminations of wood and has the engine bearer, the vertical and the diagonal struts all integral. No metal fittings are required other than those which attach the mounting to the hull and they are also utilized as wing straps. The mounting greatly simplifies construction and expedites erection. It is free of all vibration and its sturdiness and simplicity have been the subject of much favorable comment. The gas lines, etc., run down the front engine mounting struts under sheet aluminum streamliners. The entire mounting, with the exception of the front struts, is linen covered. The engine bearers are stripped with steel channels to facilitate sliding the engine in or out.

The VE-10 radiator is rectangular in shape and set above the shaft so as not to require any cutting of the core. It rests in a base pan and is bolted to the steel engine bed spreader plate; this not only makes a pleasing and simple production design but one that is very light in weight. The radiator with all piping, attachments, etc., weighs less than 35 lb., yet amply cools the motor in warm weather.

The general specifications of the VE-10 are the following:

DIMENSIONS		
Span, upper wing		36 ft. 0 in.
Span, lower wing		28 ft. 4½ in.
Overall length		27 ft. 0 in.
Overall height		10 ft. 8 in.
Chord, each wing		6 ft. 2 in.
Gap		5 ft. 8 in.
Dihedral, each wing		2 deg.
Stagger		None
Sweepback		None
Incidence		5 deg.
Angle of tail plane to propeller axis		1 deg.
WEIGHTS		
Weight, Empty		1260 Lb.
Useful Load		
Pilot and two passengers	498 Lb.	
2½ hr. fuel	120 Lb.	
2½ hr. oil	8 Lb.	
Total		630 Lb.
Total Flight Load		1890 Lb.
AREAS		
Wings (including ailerons)		300 sq. ft.
Ailerons (4)		34.4 sq. ft.
Rudder (balanced)		10.0 sq. ft.
Elevators		19.0 sq. ft.
Horizontal stabilizer		27.0 sq. in.
Fin		13.0 sq. ft.
PERFORMANCE (Fully Loaded)		
Low speed		46 m.p.h.
High speed		90 m.p.h.
Climb—First minute		125 ft.
In ten minutes		2650 ft.

The Importance of Pigmented Protective Coverings

By R. G. Dort, A.M.

The use of pigmented protective coverings on wings was begun in the U. S. Air Service some time in the winter of 1917 or in the spring of 1918. At first their use was confined to those planes to be shipped overseas. Much later the provision was made to use these pigmented coverings on all planes, combat and training alike.

For the U. S. Air Service the change was a somewhat radical one, both from the point of view of production and the point of view of appearance. It is well known that the change was instituted initially by pressure from the American Expeditionary Air Service. The reasons which led the American technical authorities in Europe to urge so strongly the pigmentation of wings were not fully understood. They were several.

Camouflage and uniformity in coloration of American Expeditionary planes with those of the Royal Air Force, and to a less extent with those of the French, may be dismissed with the mere mention. Both of these reasons were of importance, tactically and from the point of view of possible production of planes in this country for the British and French.

The most important reason for the use of pigmented coverings was, however, neither of the above. It was a reason purely technical. Pigmented protective coverings were used primarily to lengthen the life of wing coverings, to make them retain their original strength by stopping the deleterious action of the actinic rays of light on both fabric and dope, and to make the wing coverings less sensitive to changes in atmospheric conditions, thus maintaining the original tautness under varying degrees of humidity.

It has been questioned whether or not it was worth while to lengthen the life of wing coverings on battle planes at the front. It is true that the life of the planes at the front was very short—much under that of ordinary unpigmented wing coverings. It would not have been worth while to go to the extra labor of production in using pigmented coverings on battle planes for this reason alone. But on planes built for peace work, pigmentation will be worth while for this reason if for no other. Even with acetate dope, unprotected wings will loosen and the dope will crack, exposing the fabric. With nitrate doped wings this deterioration will be more rapid. From a commercial point of view the use of light protection on wing coverings will certainly pay.

In 1917 the British showed that unprotected doped fabrics (and undoped fabrics as well) lost very appreciably in tensile strength after three months or even less exposure. The French, having adopted before, for camouflage and other reasons, a doping scheme consisting briefly of one coat of clear dope, followed by two coats of pigmented dope, followed by a final coat of clear dope, were already in effect protecting their wing coverings from the light. The British Air Force specifications insisted on pigmented protective coverings on the wings of all planes at the front, even before the research on the subject was complete, so the preliminary results were so convincing. To prevent deterioration in tensile strength the technical staff of the American Expeditionary Air Service insisted on the use of pigmented coverings on all planes going to the front.

The importance of maintaining good and constant tautness of wing coverings has been elsewhere discussed. Not only do pigmented coverings retard deterioration but keep at more constant tautness the wings of planes thus protected. This, a somewhat later development, is the positive experience of the British. The experimental work of both here and in England bears this out conclusively.

The reasons for the pigmented covering maintaining more constant tautness are not as yet fully clear. The underlying reason has something to do, undoubtedly, with retarding the penetration of water vapor through the covering layers into the fabric. Acetate dope films are well known to be porous to water vapor. In any case it is a fact that wings with proper pigmented coverings will show far less fluctuation in tightness under varying humidity conditions, than those finished with clear dope.

The above arguments for using pigmented protective coverings were almost entirely based on information cordially and willingly furnished by the British, at the Royal Aircraft Establishment and at the head office and laboratory of the Aeronautical Inspection Department of the Royal Air Force. Too much appreciation cannot be expressed for the friendly feeling of confidence which the technicians of these two organizations showed toward the American investigators and engineers in these wing coverings, as in many other matters. This information reaching this country through divers channels was the direct reason for the use of pigmented protective coverings in the U. S. Air Service.

Why was it that so much trouble was experienced here in the use of pigmented coverings? Largely choice of material.

The U. S. Air Service started using pigmented oil varnishes (enamels). It is true that at the time this country entered the war these were the materials which the British were using. But it was not from choice. The British preferred the use of a pigmented covering of the so-called pigmented dopes type, instead of a pigmented china wood oil varnish. For reasons of supply they were obliged to revert to the latter type, although still using a pigmented dope covering (wherever on hand) for repair work in the field. In this country enamels were used. Not only was production retarded by the time of drying required by these pigmented varnishes (this fault continued so long as pigmented varnishes were used), but it is certain that in many cases at least, wing covers of satisfactory tautness were nearly ruined by the loosening action of some of the solvents in the enamel. This has been laid to the turpentine in the pigmented oil varnish. It is well known that certain compounds of the pinene series are solvents of a cellulose acetate film; i. e., that they cause a distinct softening and hence slackening in a cellulose acetate film. It is also well known that on standing, turpentine will develop some of these compounds. The conclusion that an excess of turpentine, or possibly turpentine which had aged considerably, was being used by some of the enamel manufacturers and hence caused this trouble, seems reasonable and is somewhat borne out by laboratory results. Not enough work has been done, however, to make a positive statement on the matter.

The pigmented protective coverings of the pigmented dopes type—such as the British P. C. 10—have not the two drawbacks of long drying time and slackening tendency. That is to say they dry quickly, as quickly as dope, and they have no tendency to slack off the tautness given the wings by the dope. In fact, with regard to this latter point a certain pigmented dope used in this country by the Air Service as a pigmented protective covering has shown in tests that it actually gives slightly greater tautness to the wings.

For the two reasons of time of drying and slackening effect alone enamels have been practically rejected and coverings of the dopes type (pigmented) substituted.

There is a reason, military and camouflage in nature, why pigmented coverings of the dopes type are superior to those of the enamel type. From the point of view of camouflage it is essential that the surfaces of a combat plane be so finished, that there will be a minimum of reflection or flash in the rays of the sun. Coverings of the pigmented dopes type dry naturally with a matte surface—a surface smooth, yet with a very dull finish. It has been impossible to obtain any covering of the pigmented oil varnish type which will produce a similar result.

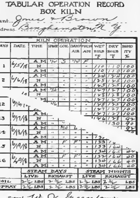
What then is the best pigmented protective covering to use? Not an enamel, nor any other kind of a slow drying, pigmented oil varnish, but a covering of the pigmented dopes type. There were three firms in the United States in the spring of 1919, manufacturing pigmented coverings of the dopes type. In one instance the product was entirely satisfactory in all colors. The other products, more recently developed than the first, were fairly satisfactory in the standard khaki. Doubtless by the time this article is in press, progress toward the perfection of these two coverings in all colors will have been made.

Airplane Demand and the Art of Kiln Drying

By Thomas D. Perry

Few are the trades or arts which have not been profoundly impressed by our participation in the Great War. The normal progress of ten years has been crowded and condensed into four and in some cases into less than two years.

Wood workers, an admittedly unscientific and paternalistic group, had unprecedented pressure brought to bear to pro-



TABULAR OPERATION RECORD
BOX KILN

Plant Jones & Brown
Address Binghampton, N. Y.

KILN OPERATION									
DAYS	DATE	TIME	SPRAY	COIL	DAMP AIR	FRESH AIR	WET BULB °F	DRY BULB °F	HUMIDITY %
1	6/5/18	A M	¼	S	½	F			
		N				"	110	110	100
		A M	"	"		"	110	110	100
2	6/6/18	A M		"	"	"	124	124	100
		N		"	"	"	125	125	100
		A M		"	"	"	125	125	100
		A M	¾	"	"	"	127	127	100
11		N			"		128	128	100
		M	"	"	"	"	127	127	100
12	6/16/18		[illegible]		"	"	125	125	100
					"	"	127	127	100
						"	127	127	100
13	6/17/18	A M					126	128	92
		N	"					130	90
		A M	"						92
14	6/18/18	A M		3/4	[illegible]				
		N	"	"	"				
		A M	"	"	"	"	13[illegible]		
15	6/19/18	A M	"	F	F	"	133	1[illegible]	
		N		"	"	"	133	164	
		A M	"	"	"	"	134	165	42
16	6/20/18	A M		F	F	"	132	164	40
		N		"	"	"	134	166	40
		A M	"	"	"	"	134	166	40

	STEAM DAYS LIVE	STEAM DAYS EXHAUST	STEAM NIGHTS LIVE	STEAM NIGHTS EXHAUST
COIL	2½ LBS	2½ LBS	2½ LBS	2½ LBS
SPRAY	2½ LBS	2½ LBS	2½ LBS	2½ LBS

Signed W. J. Green Operator.

KEY:
S-½-1-2-3-4-F—Represents Number of Turns Spray or Coil Valves are Open.
S-¼-½-¾-F—Represents Amount Fresh or Damp Air Dampers are Open.

Fig 1

duce and produce, not their regular output of lumber, furniture, pianos and the like, but an unheard-of volume of airplanes, gunstocks, motor transports, emergency housing, wooden ships, and other products of the forest.

The normal mill and yard stocks of lumber (air seasoned, and ready for use) were soon depleted and the big problem became dominant: how to turn the forests into war products, delivering the completed goods almost before the leaves had wilted.

As an instance of one of the major problems of the woodworker, we may take the airplane, because it is more exacting and perhaps the most typical in its varied requirements. Before 1914, aeroplanes (as they were then called) had been built of lumber, air seasoned for three years. The few aeronautical engineers of those years based all their strength calculations on such three-year lumber, and there was none to be had, and airplanes had to be built by the thousands and at *once*.

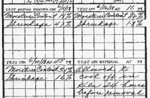
We are too near to the emergency solution of the problems under the stress of war times to see the true perspective of what has happened and to grasp its entire significance. There are a few landmarks of progress that stand out and we can all use them in measuring our own advancement. These may be grouped under the following headings:

1. Development of maximum strength of wood.
2. Adoption of drying specifications.
3. Utility of drying records.
4. Necessity of whole time operators.
5. Laboratory co-operation.

1. *Maximum Strength.*—The airplane was the first piece of fabricated woodwork to demand a maximum strength per pound weight. Pianos were admittedly heavy, and substantial, but there existed no urgent demand to reduce their weight to a minimum. If table legs were not strong enough or sufficiently rigid, it was easy to make them larger without lessening the utility of the table. In chairs of the "period" type, furniture manufacturers made a short excursion into the field of maximum strength in minimum sizes, but the resulting designs were more satisfactory from an artistic standpoint than for durability and strength.

It remained for the airplane to demand, and at the price of the risk of the life of its operator, a wood fabrication in fuselage, wing spar, strut and propeller, with the greatest possible resistance to breakage and with the least possible weight. There were no rules, nor tables, nor accumulated data

LUMBER TESTS



CAR No	M FEET	KIND	THICKNESS	MOS AIR DRY	MOIST CONT	SHRINKAGE	CAR No	M FEET	KIND	THICKNESS	MOS AIR DRY	MOIST CONT	SHRINKAGE
		Mag.	8/4		19%	4.7%							

TEST BEFORE DRYING ON 6/5/18	TEST ON 6/16/18 AT 11. M
Moisture Content 19%	Moisture Content 8.2%
Shrinkage 4.7%	Shrinkage 1.8%
TEST ON 6/20/18 AT 4 P M	TEST ON REMOVAL AT M
Moisture Content 5.1%	Allowed to
Shrinkage 1.6%	cool off in
	Kiln 24 hours
	before removal

Fig 2

to work from. The Bureau of Standards at Washington had practically nothing. The Forest Products Laboratory at Madison had started a method, adopting standard sizes and standard methods of testing, to determine the modulus of rupture, the elastic limit, and the breaking strength, transversely and torsionally. The available, but meagre, results were hastily compiled and put at the service of the Signal Corps of the

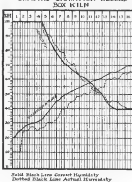
United States Army. New tests were started by the more enterprising manufacturers of dry kilns and by the Forest Products laboratory. The final results of the war experience on lumber strength were as follows:

(A) Lumber properly kiln dried is as strong, if not stronger than air dried.

(B) The density, specific gravity, and frequency of growth rings have an important bearing on strength,—i.e. uniform growth rings eight to twelve per inch are best for strength, sap wood has more resiliency than heart wood, etc.

(C) Hickory, oak and ash in the order given, are the woods with the greatest fibre adhesion (greatest torsion or twisting strength) and are most suitable for heavy duty, like landing gear, wheels, etc.

GRAPHIC OPERATION RECORD
BOX KILN



Solid Black Line Correct Humidity
Dotted Black Line Actual Humidity
Solid Red Line Correct Temperature
Dotted Red Line Actual Temperature

Fig 3

(D) Maximum strength can be secured for any work by judicious selection, sawing or splitting with the grain, kiln drying without producing internal strain, and proportioning sizes to the strains to be met.

2. *Drying Specifications*.—Several companies manufacturing dry kilns had ventured in the past to furnish cards or sheets of operating instructions, and one had published a booklet on the subject, but the lumber producer and the lumber user had regarded such efforts as visionary. Lumber was chiefly dried by the good old fashioned way, "by guess and by gosh." Signal Corps Specification No. 20,500 on "General kiln drying for airplane stock" was regarded as merely another species of official red tape, desirable to be broken rather than observed. The writer holds no brief for the defense of the aforesaid specification, for it erred in several ways. Probably its ultra conservatism for low temperatures and limited operating ranges were responsible for substantial reduction of output. But the basic principle of a drying specification was definitely established and it will henceforth be much easier for the commercial kiln dryer and consumer to agree on specifications and methods to secure quality and quantity output.

3. *Drying Records*.—The establishment of strength tests and specifications led obviously to the use of record blanks, to indicate the degree of compliance with the established standards. The following are submitted for commercial uses, as the result of the writer's war time experience.

The daily tabular record (Fig. 1) requires three daily readings, sufficient for all but the most exacting work. Fig. 2 is for preliminary tests, to determine the period of drying and range of temperatures and humidities, and then for the pre-final and final tests to show when lumber can be safely removed from dry kiln. Fig. 3 shows a graphic chart in which the full lines show the proper drying schedules determined from the preliminary tests in Fig. 2, red indicating temperature and black humidity. The dotted lines show the graphic plotting of the tabular record (Fig. 1) and are made daily by the operator as a check upon his operation.

A fifteen-year experience of the writer and his associates in the dry kiln business has proved the following:

(A) That dry kilns and their operations have been regarded as trouble developers, a fact grudgingly admitted by kiln designers and builders.

(B) That kiln operators, who keep adequate records have very little trouble.

(C) That over 90 per cent of the cases of kiln trouble reveal, upon investigation, that either no records were kept or they were too scanty to be serviceable; that is, the keeping of a proper record would have enabled the operator to eliminate the trouble from the start.

4. *Whole Time Operators*.—Since the invention or adaptation of dry kilns, there has been no device or piece of equipment in a wood working plant so carelessly handled as the lumber kiln. Sometimes it is added to the duties of the yard foreman, or lumber scaler, or engineer, or cut-off sawyer, or any one else alleged to have spare time.

The realization of the need for a whole time operator was first publicly developed in a meeting of the dry kiln committee of the Southern Pine Association in New Orleans in 1914. Of the hundred odd large mills reporting less than half even admitted having a kiln operator, much less having a skilled or trained operator. It was agreed, however, that a competent operator could save many times his wages—as well as stimulate the production of a better quality of stock.

One of the larger kiln companies had for years advocated efficient operators devoting their whole time to the kilns, but it remained for the establishment of tests and specifications during war time stress to demonstrate the necessity of a trained operator as an integral part of a wood working plant, and once having been substantially appreciated, he will remain as a fixture.

5. *Laboratory Co-operation*.—The manufacturer of iron and steel, the manufacturer of paper pulp, in fact the manufacturer of most commodity products, have learned to coordinate properly the research laboratory and the practical processes of manufacturing. It is well understood by them that the function of a laboratory is research, investigation and experimentation, in other words, a man to be a successful investigator must have the type of mind that thinks in theoretical rather than in business terms, and works in the purely scientific realm. The practical man must learn to take and apply this theoretical and scientific knowledge in a way to manufacture economically and efficiently.

In the estimation of the writer wood workers have not learned the first rudiments of adapting laboratory service to their problems. Until the wood worker does learn to manifest this ability he will continue to rank as a relatively unscientific and crude artisan.

There is at Madison, Wis., a forest products laboratory maintained jointly by the United States Government and the University of Wisconsin. It has a capable staff, all of whom are experts in wood research lines. The services of the laboratory have been freely offered to forest utilization manufacturers on various wood problems. It required a war, however, and the emergency of war work, to bring the laboratory and the practical man into touch with each other. That touch was mutually beneficial, but like all war work was done without regard to cost and expense. The problem since the close of the war is a better co-ordination and co-operation between the laboratory man and the practical manufacturer. Both have been remiss in their methods of approaching each other. For example: The water spray kiln of the forest products laboratory is theoretically sound, but commercially little less than a failure because it has not yet been adapted to the work-a-day field by experienced men, who know how to utilize equipment efficiently and at a profit. It therefore remains a good idea badly applied, and is less serviceable to the practical manufacturer than a less scientific idea which has been properly developed and adapted.

If the results of the war shall be a better understanding of practical working conditions by the laboratory staff and a greater desire for laboratory help on the part of the manufacturer, it will have rendered a service that many years of peace failed to bring about.

There is a wonderful field ahead for proper co-operation between such laboratories as the forest products laboratory and the manufacturers, if each will recognize their own part of the problem and their own limitations.

N. A. C. A. Election

The annual meeting of the National Advisory Committee for Aeronautics was held in Washington on Oct. 9, 1919. Dr. Charles D. Walcott was elected Chairman for the ensuing year, and Dr. S. W. Stratton, Secretary. Members of the Executive Committee were elected as follows: Dr. Joseph S. Ames, Col. Thurman H. Bane, U. S. A., Capt. Thomas T. Craven, U. S. N.; Dr. John F. Hayford, Prof. Charles F. Marvin, Maj.-Gen. Charles T. Menoher, U. S. A., Dr. S. W. Stratton, Rear-Admiral D. W. Taylor, U. S. N., Dr. Charles D. Walcott.

The Executive Committee proceeded to organize for the coming year and elected Dr. Joseph S. Ames, Chairman, and Dr. S. W. Stratton, Secretary.

The appointment of Prof. George W. Lewis as Executive Officer was confirmed. Estimates for the fiscal year 1921 were approved in the sum of $437,000.

In addition to the functions specifically defined for the various subcommittees, the general functions of the committee were defined as follows:

First.—Under the law the Committee holds itself at the service of any department or agency of the Government interested in aeronautics for the furnishing of information or assistance in regard to scientific or technical matters relating to aeronautics, and in particular for the investigation and study of problems in this field with a view to their practical solution.

Second.—The Committee may also exercise its functions for any individual, firm, association, or corporation within the United States, provided that such individual, firm, association, or corporation defray the actual cost involved.

Third.—The Committee institutes research, investigation, and study of problems which, in the judgment of its members or of the members of its various subcommittees, are needful and timely for the advance of the science and art of aeronautics in its various branches.

Fourth.—The Committee endeavors to keep itself advised of the progress made in research and experimental work in aeronautics in all parts of the world, particularly in England, France and Italy, and will extend its efforts to the securing of information from Germany and Austria.

Fifth.—The information thus gathered is brought to the attention of the various subcommittees for consideration in connection with the preparation of programs for research and experimental work in this country. This information is also made available promptly to the military and naval air services and other branches of the Government, university laboratories, and aircraft manufacturers interested in the study of specific problems.

Sixth.—The Committee holds itself at the service of the President, the Congress, and the executive departments of the Government for the consideration of special problems which may be referred to it, such as rules for international air navigation, method of regulation and development of civil aerial transport, technical development policies of the military, naval, and postal air service, etc.

Book Reviews

AIR NAVIGATION, NOTES AND EXAMPLES. By Capt. S. F. Card. (140 pp. 61 figs. Longmans, Green & Co., New York.)

As the author very correctly states in his preface, the subject has been treated in a very elementary manner, and nothing beyond a knowledge of arithmetic and a slight acquaintance with geometry are required to understand all the problems dealt with.

With the ever-increasing need of careful air navigation, the book is sure to find a wide circle of readers.

Beginning with a few elementary definitions which every one has known but never remembers, Captain Card gives those very slight astronomical notions which every one should possess, particularly if he is a pilot.

The measurement of direction is briefly and accurately explained. Position by cross-bearings is apparently a very simple matter. The use of the magnetic compass and the taking of bearings are within the grasp of average intelligence. Course and distance calculations are clearly explained. Every bit of information is followed by a practical example.

Captain Card is the head of the Navigation Department at the Royal Naval College, and he must be an excellent teacher if one is to judge him by his present work. "Navigation Self-Taught" might be a proper title for this excellent book. We feel grateful to him for reducing the subject to a layman's grasp.

It must be pointed out, however, that the data on wind and weather is of too sketchy a nature to be of much practical service.

THE CHEMISTRY AND MANUFACTURE OF HYDROGEN. By P. Litherland Teed. (Longmans, Green and Co., New York, 152 pp., many diagrams.)

With the increasing possibilities of airship work no publication could be more timely than the present volume, the literature on the technology of hydrogen being small and difficult of access to anyone but a chemist.

The book is written in very simple fashion, so as to be easily understood by anyone at all familiar with chemical symbols.

The index of contents gives a very fair idea of the ground covered: 1. Hydrogen—Its Uses—Discovery and Occurrence in Nature. 2. The Chemical Properties of Hydrogen. 3. The Manufacture of Hydrogen. Chemical Methods. 4. The Manufacture of Hydrogen. Chemico-Physical Methods. 5. The Manufacture of Hydrogen. Physical Methods.

Besides a sound theoretical treatment of the subject, Major Teed's work gives a practical description of the various processes, with general description of plants, figures on input of materials and output of hydrogen, precautions in operation, purity, and so forth.

As far as we can see, every important method is covered, Silicol, Aluminal, Water Gas method, Iron Contact, etc.

To any one interested in the layout of hydrogen plants for airship or balloon work, the treatise will prove invaluable.

AIRPLANE ANTENNA CONSTANTS. (Bureau of Standards, Washington, D. C.)

A new publication of the Bureau of Standards, Scientific Paper entitled "Airplane Antenna Constants," is now available for distribution.

Methods for measuring the capacity, inductance, resistance, and natural wave length, also the directional transmitting effect of airplane antennas, with the plane in flight, are described. Using these methods, results obtained upon various forms of fixed antennas as well as one, two and four trailing wires are recorded.

Tension in Diagonal Airship Bracing Wires*

By E. H. Lewitt

Fig 1 represents a portion of a rigid airship, A_1 A_2 A_3, etc., being the area of the respective longitudinal girders, Y_1 Y_2 Y_3 etc., being their vertical distances from the longitudinal axis of the ship The vertical downward force of the loads and the upward lift of the gas causes a vertical shear force and bending moment on the ship The problem is to find how much of this shear force is taken by each diagonal wire.

It is necessary to make the following assumptions.—

(1) That the ship bends about a neutral axis, which passes through its centre of area.

(2) That the longitudinal girders take the bending stresses only

(3) That the diagonal bracing wires take all the shear

(4) That all the loads are concentrated at the transverse frames.

Consider a section of the ship between any two transverse

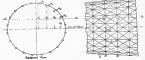


Fig 1

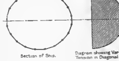


Fig. 2.

frames AB and CD, take a horizontal section xx through any panel, cutting AB and CD at E and G respectively.

Let R_1 be the radius of the ship at frame AB
" R " " " " CD
" M_1 be the bending moment at frame AB
" M " " " " CD
" I_1 and I be the moments of inertia of the ship's cross section about a diameter at AB and CD respectively

As the moment of inertia of the ship's cross section is proportional to (radius)^4,

then

$$\frac{I_1}{I} = \frac{R_1^4}{R^4} \qquad I_1 = \frac{IR_1^4}{R^4}$$

Let Q_1 and Q be the moments of area of the ship's cross-section above the line xx about the centre of area at AB and CD respectively

As the moment of area varies directly with the radius, then

$$\frac{Q_1}{Q} = \frac{R}{} \qquad Q_1 = \frac{QR}{R}$$

Let T = Tension in diagonal wire cut by the line xx
" a = Inclination of panel to the longitudinal axis of the ship
" β = Inclination of diagonal wire to transverse girder, measured in the same plane as the girder

Then the component of the diagonal bracing wire to longitudinal axis of the ship

$$= \cos a \sin \beta$$

The stress on any longitudinal girder due to bending

$$= f = \frac{My}{I}$$

Total force on any longitudinal girder

$$= f \times \text{area} = \frac{MyA}{I}$$

Consider the equilibrium of the section $AE\ GC$.—The forces in the longitudinal girders due to bending will cause a thrust or pull on the section AE Similarly, another thrust or pull will be caused on CG. The difference between these will be taken by the two diagonal wires cut by the line xx. (One on each side of the ship; the wires acting as counter-braces will be out of action as the tendency is to put these wires in compression.)

Resolving horizontally—

Total force on

$$AE = \frac{2A_1Y_1M_1}{I_1} + \frac{2A_2Y_2M_1}{I_1} + \frac{2A_3Y_3M_1}{I_1}, \text{ etc.}$$

$$= \frac{M_1}{I_1}(2A_1Y_1 + 2A_2Y_2 + 2A_3Y_3, \text{ etc.}),$$

but $(2A_1Y_1 + 2A_2Y_2, \text{ etc.})$ = moment of area = Q_1.

From this it follows that the total force on

$$AE = \frac{M_1Q_1}{I_1} = M_1 \times \frac{QR_1}{R} \times \frac{R^4}{IR_1^4} = \frac{M_1QR}{IR_1}$$

In the same way—

Total force on

$$CG = \frac{MQ}{I}$$

The difference between these forces is balanced by the horizontal components of the tensions in the two diagonal wires (Port and Starboard)

$$2\,T \cos a \sin \beta = \frac{MQ}{I} - \frac{M_1QR}{IR_1}$$

$$= \frac{Q}{I} \times \left(M - M_1\frac{R}{R_1}\right) \qquad T = \frac{Q\left(M - M_1\frac{R}{R_1}\right)}{2\,I \cos a \sin \beta}$$

In parallel portion of the ship—$R_1 = R$ and $a = 0$ then

$$T = \frac{Q(M - M_1)}{2I \sin \beta}$$

Let F = shear force in bay considered, this will be constant between two transverse frames as all loads are assumed to be concentrated at the transverse frames, but $dM = F\,dx$

In this case dx = distance between two transverse frames $= L$, and $dM = (M - M_1)$

$$(M - M_1) = FL \qquad \therefore T = \frac{QFL}{2\,I \sin \beta}$$

Between any two transverse frames, F, L, I and $\sin \beta$ are constants then T = constant $\times Q$

Thus a diagram showing the variations in the tensions of the diagonal wires between two transverse frames will be as shown in Fig 2, the tension varying with the moment of area above the panel considered The maximum tension will be in the wire opposite to the centre of area of the ship's cross-section

* Courtesy of *Aeronautics*

The Curtiss Eagle Transport Airplane

The Curtiss Aeroplane and Motor Corp has just added a new type to the family of commercial airplanes—the Oriole land machine and the Seagull flying boat—which this firm has produced since the signing of the Armistice The latest machine, called the Eagle, was designed to meet the needs of commercial aviation for an airplane capable of carrying a medium load of passengers, or freight, at an economical cost Seating accommodation is provided for eight persons, including one or two pilots, with the seats removed, if need in freight or express service, the Eagle carries more than a ton of useful load

Three Quarter Front View of the Curtiss "Eagle"

The Curtiss Eagle—the first three-engined machine of American design produced in this country—essentially differs from other existing multi-engine airplanes in that it is a triple tractor, which marks a new departure in airplane design. This novel feature was thoroughly tried in exhausting test flights lasting two months before the machine made its first public appearance, on Sept. 29, inst., in the hands of Roland Rohlfs, Curtiss test pilot, and has given entire satisfaction.

The advantages to be derived from splitting up the power plant into three independent engine units are obvious. The Curtiss Eagle, which is fitted with three Curtiss K-6, 150 hp. engines is designed to fly well on any combination of two engines. At three-quarters load, or at the end of a journey when the weight of the gasoline has been reduced, the machine will even fly on one engine, with near full load at 6,000 ft. level and two engines cut out, the Eagle has a gliding range of ten miles, which is ample to insure a safe landing in any but outright hilly country The merits of the triple engine arrangement thus becomes self-explanatory

In its general outline the Eagle may be described as an ordinary tractor fuselage biplane which is fitted with additional wing engines and propellers

The fuselage is of streamline form, built of plywood and giving lightness as well as strength. The nose accommodates the central engine, back of which the fuselage expands into a comfortable cabin containing eight upholstered wicker chairs band with whipcord and arranged in two rows, with a passageway between The dome-light flat windows are of triplex non-breakable glass, the curved windows of celluloid The front seats are equipped with dual Dep control, the pilots have a clear vision over the center engine owing to the raised position of the cabin and the liberal size of the windows. In the rear of the cabin a cupboard is provided for luggage.

The tail unit is similar in its general arrangement to that of the Curtiss Oriole and is braced by streamlined steel struts, without any external wires.

The landing gear consists of four wheels arranged in tandem pairs and enclosed in streamline casings

The main planes are 61 ft. 4 in. in span and have a chord of 6 ft. 9 in giving wing area of 770 sq ft., have neither dihedral, stagger or sweepback Fully loaded the machine weighs 7,450 lb, the useful load is 2,320 lb

The performances of the Eagle are as follows: high speed 107 m.p.h., low speed 54.6 m.p.h., climb 4,075 ft. in 10 min. Endurance 350 miles at full power in 3 1/3 hr and 475 miles at cruising speed of 75 m.p.h. in 6 1/3 hr.

Adjustable Pitch Propeller for Airplanes

Preliminary tests of an adjustable pitch propeller for airplanes, designed by Spencer Heath, have been made at the Aeronautical Engine Testing Laboratory, Navy Yard, Washington, D C The propeller was fitted to a Hispano-Suiza 150 hp. engine and operated at various speeds up to full power The adjustable mechanism worked satisfactorily and the design appeared to have plenty of strength Final reports on the propeller will not be submitted until after a whirling test is made at McCook Field It is designed to give variable speeds without throttling the engine and also for use as a break in landing

Differences Over Airship Undecided

The use of rigid type of airship by the Army and Navy has been referred to the Joint Army and Navy Board on Aeronautics. The question as to which Service should have authority over experimentation and production of the rigid airships has been the subject of long discussion by the Board on Aeronautics, the Navy contending that the development of this type was a Navy function exclusively and the Army maintaining that there were military as well as naval uses for the dirigible ship The Board on Aeronautics failed to agree, and as a result the matter has been referred to the Joint Army and Navy Board for further consideration


HISPANO-SUIZA
Aeronautical Engines
EXHAUSTIVE tests after final assembly have insured the altogether wonderful performance of these motors
The recently made world's altitude record for seaplanes of 18500 feet was achieved with a 300 H.P. Hispano-Suiza Aeronautical Engine
Wright-Martin Aircraft Corporation
New Brunswick, N.J.
MOTOR ASSEMBLY
BELT TEST - 300 H.P.

The Vickers-Vimy Commercial Airplane

This airplane is a modification of the Vickers Vimy Bomber, which was the prototype of the Vickers Vimy Transatlantic, this is merely mentioned to show that the airplane has been flown under stringent war conditions, and to call attention to the obvious advantage of an airplane that can be used either for war or commercial purposes by the rapid interchangeability of the respective fuselages. Indeed, the different fuselages constitute the only departure between the three types mentioned.*

The fuselage is constructed on the monocoque principle, which consists of the shell of the cabin being attached to oval wooden rings of box section. These rings are built up of three ply, are light, and have immense strength The shell or cover of the cabin is made of Consuta patent, an entirely new principle superseding three-ply, being manufactured by S. E. Saunders, Ltd., of Cowes, and is constructed of thin layers of selected wood, the grain placed diagonally, and then glued and sewn together, the rows of stitching running in parallel lines about 1½ in apart The strength of this material is very great, gives a high factor of safety to the whole construction of the cabin, and entirely dispenses with any crossbracing wires in any direction, the absence of which adds materially to the comfort of the passengers (see Figs. 2 & 3). The doors are watertight, and the machine will float in a normal position on water. Two pilots are carried side by side, the cockpit being placed high up in the nose giving them a wide range of vision, dual controls are provided throughout

The dimensions of the Vimy Commercial are as follows

Overall length ...	42 ft. 8 in
Overall height	15 ft 3 in
Span	67 ft 0 in
Gap	10 ft 0 in.
Chord	10 ft 8 in

Engines—Two Rolls-Royce "Eagle" Mark VIII engines are installed, giving a total of 750 hp Should one engine fail completely, the machine can fly on the other engine alone at a speed of 70 miles per hour

Speed—

Maximum	110 m.p.h.
Cruising	90 m.p.h.
One engine	70 m.p.h.
Landing speed	45 m.p.h.

The cabin is totally enclosed, and has a seating capacity for ten passengers in separate arm-chairs; a gangway runs down the centre of the car, and there is ample space between the chairs, the passengers being in no way crowded. Cupboards are provided at the end of the cabin for the storage of light hand luggage A separate window is placed at the side of each person, and both height and speed indicators are fitted for those who are interested in the new conditions of travelling, further, telephonic conversation can be carried on between the pilot and the passengers, and the matter of ventilation and heating can be adjusted as desired to suit any temperature conditions Noise has been reduced to a minimum, and vibration entirely eliminated

The seats in the cabin can be detached in a few minutes, giving a floor area of 53 sq ft, and a volumetric capacity of 300 sq ft for freight, which can be kept at an even temperature and dry The maximum weight which can be carried is 2,500 lb For mail-carrying sorting boxes are fitted and sorting can be carried out in flight.

A new type of cabin is now in course of construction, and will shortly be ready The outstanding feature of this construction will be a modification of the passengers' chairs, to provide a total accommodation for fifteen passengers. This new arrangement will consist of separate arm-chairs arranged in five transverse rows of three, the central seat of each row being removable to allow passengers to reach their places; the chairs can readily be removed if mails or goods have to be carried. A lavatory is also fitted. The maximum weight which can be carried on this type has been increased to 1½ tons.

Quarter Side View of the Vickers "Vimy-Commercial" Airplane Fitted with Two 375 hp Rolls-Royce Engines

* See the July 1, 1919, issue of Aviation and Aeronautical Engineering.

The Fiat Airship Engines

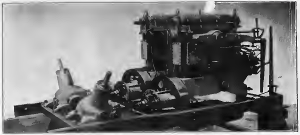


Fig 1 Twin Installation of Fiat 4-Cyl. Airship Engines

During the war Italy made a very extended use of airships for coastal patrol work and for the detection of submarines in the Adriatic and the Mediterranean The great majority of these airships were equipped with Fiat engines. The size and type of engine varied with the airship, but a very popular installation was a twin group composed of two four-cylinder engines placed side by side, and as close together as possible, in a channel section frame (Fig 1) These engines have a bore and stroke of 110 by 190 mm, the cylinders being a block casting, with enclosed valves in the head and large aluminum water jacket plates on the sides and the ends. The overhead camshaft is operated by means of an enclosed vertical shaft and bevel gearing, and advantage is taken of this shaft to mount the starting gear by means of a lever and bevel gearing The carburetor is placed on the outside of each engine, while the exhaust is on the inside.

At the base of the vertical shaft the water pump and the high-tension magneto are driven by means of bevel gearing. These two organs are opposed, so that the magneto distributors and contact breakers are on the outside in each case Each engine is fitted with a light flywheel and a spiral spring clutch, the control of which is by means of a level at the forward end of the engine From the clutch shaft the propeller shaft is driven by means of bevel gearing, this shaft having an inclination of about 45 deg from the vertical

For the Forlanini airships a distinct engine has been produced by the Fiat Co This is a 6-cyl type having four valves per cylinder on opposite sides (Fig 3). The cylinders are cast

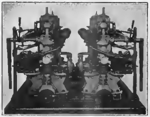


Fig 2 End View of Fiat 4-Cyl. Twin-Engine Installation

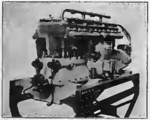


Fig. 3 Fiat 6-Cyl. Airship Engine

in pairs, and are fitted with steel liners. Their bore is 125 mm. and the stroke 190 mm.; the indicated horsepower is 147

This engine has been specially designed with a view to make possible quick repair while in flight. The valves are not enclosed and can be changed readily. There are two oil pumps, mounted on the extremities of the camshafts. The magnetos are at the opposite end of the engine, driven from a short cross shaft, but having their distributors and contact breakers outwards for greater accessibility. The carbureter is a double type with independent float chambers, but having a common water jacket.

Trade Reviews

Malleable Iron, Its Properties and Uses

The American Malleable Castings Association is apparently organized on a non-commercial basis to further the interests of the Malleable Castings industry. Its booklet, which we take much pleasure in reviewing, is a very authoritative study of malleable cast iron.

The process of making malleable iron castings may be briefly outlined as follows. It consists, first, of melting in an air furnace, open hearth, or electric furnace, a properly proportioned mixture of pig iron, with sprue or scrap castings from some previous heat, and possible additions of steel scrap. The bath is refined until enough silicon has been removed from the iron to force all of the carbon to remain combined in the resultant product and the consequence is that, after the iron has been cast in previously prepared moulds, the castings will possess a white fracture with the accompanying hardness and brittleness incident to the condition. Second, the subjecting of these castings to a heat treatment in suitably designed ovens where they are heated to redness for several days.

Through this heat treatment, or "annealing," the extremely hard carbide of iron of the white castings is broken up into two soft constituents, carbonless iron, or ferrite, the most ductile constituent in any iron product, and free carbon. Coincident with this transformation some of the carbon is removed from the castings, both factors serving to convert the hardest possible product into one which is soft yet very tenacious.

We see then that the process consists of a refining operation followed by a heat treatment, and, when properly carried out, gives us a product consisting wholly of ferrite containing more or less free carbon, the carbon being uniformly distributed throughout the area of the section.

Bars of similar character can give an ultimate strength of about 58,000 lb. per sq. in. and an average elongation of 22 or 23 per cent.

Malleable iron casting is far superior to gray iron in ultimate strength and elongation. Its ultimate strength is lower than that of cast steel, but it approaches that metal in elongation, and what is also important, its elastic limit closely approaches its ultimate strength. Beside this, is the fact that malleable iron in its molten state is more fluid and may be poured at a lower temperature than steel, hence it produces a casting which is more likely to be free from blow-holes and permits the use of a low factor of safety in the engineer's computations.

Martin Transport Airplane

The Martin Transport airplane, which recently flew with a crew of four from Cleveland, O., to Dayton, O., in 1 hr. 50 min., is an adaptation of the Martin Bomber to the needs of commercial aviation. The new machine seats twelve persons, including the pilot, four seats being fitted forward of the fuel tanks, and eight in two tiers aft. The two compartments are reached by separate trap doors, giving easy access, and are inter-connected by a passageway.

The fuselage is deeper than that of the Bomber, a streamline roof having been added for the protection of the occupants against weather. Windows of Pyralin, a celluloid composition, are let into the nose and sides of the machine and permit a wide sweep of view in all directions.

The Martin Transport was produced at the request of the U. S. Army for the carrying of officers engaged in inspection tours and of machine gunners to threatened points.

Center Portion of the Martin Transport Airplane's With Rear Trap Door Opened for Ready Access of Occupants

The Lawson Airplane C-2

The Lawson airplane C-2 has been constructed strictly as a commercial, not a war, type. It has been designed with the view of carrying passengers, but by removing the seats, either mail or express or similar cargo can be carried.

Main Planes.—The main planes are of equal span and are made in seven sections, the outer ones being hinged to the center panels. The two lower engine panels are likewise hinged to the fuselage. This as well as the fact that all the struts are hinged-jointed at their ends indicates the reason why no vibration is felt in the cabin even though the motors are fully advanced.

There are four large struts attaching the top center panel to the body. This is also braced by four steel tubes running diagonally down to the body from this panel which help to carry the drift stresses in flight as well as brace the fuselage against any whipping action caused by forces on the tail.

The Lawson Airplane C-2, Fitted with Two Liberty-12 Engines and Accommodating Two Pilots and Twenty-four Passengers

(c) *G. V. Buck, from Keystone View Co*

Each outer panel has two sets of wing struts. These are of laminated spruce and are socketed by hinge connections to special steel fittings. All external and internal bracing is by hard cable.

After repeated tests on different forms of ribs one was finally adopted where the strength per weight ratio is extremely high. This type of rib is cross-braced at certain points along the section according to the loading carried during flight. In this way the strength is used where it is mostly needed. They are constructed entirely of spruce and are of I section, excepting those at the external strut points. These, as well as the internal compression ribs and those at the foot of the panel, are all of the box type.

The wing spars are of the usual I-section and are of solid spruce. Hardwood blocks are placed at strut connections to take care of the great load on the wires as are found in large machines of this size. It will be noted there is much in similarity between the upper and lower outer panels.

On each end of the wings (both top and bottom) are placed balanced ailerons. The balanced portion is neatly designed so as not to project outside the wing proper where it is more liable to be caught and broken off while on the ground. This is accomplished by using a third spar placed between the usual front and rear spars and braced by special construction internally.

The aileron control cables pass through both upper and lower wings out to these surfaces, being interconnected by four cables between each pair of ailerons. The main load of these surfaces is not carried through the control wheels since the lower cable runs from one lower aileron clear across to the opposite one. Attached to this line is a separate cable running up to the control wheels.

Tail Unit.—The tail is of the biplane form, thus distributing the stresses more readily and also allowing a large area within a more compact space, at the same time providing a good aspect ratio.

The lower plane is hinged on the front spar to a special veneer braced strut in the body, while the lower rear spar attaches to clips on the stern post.

While the struts of the stabilizer themselves are of steel tubing, the spars and ribs are constructed of wood similar to the main wings. The front tubes help to form the fins whose internal construction is entirely of tubing. The rear tubes act as pivot posts for the two outer rudders. These are of the balanced type, while the center rudder which is not balanced is directly hinged to the stern post and center fin. With the exception of the two outer rudders all control surfaces are hinged by the male and female eyebolt system. All similar controls, as in the case of the ailerons, are interconnected by cables. Only the upper stabilizer is made adjustable.

Landing Gear.—A simple but outstanding feature is the landing gear. Two sets of Vees are used, one under each engine, these are constructed of heavy steel tubes faired with balsa wood (which incidentally is used to fair all exposed tubes). The spreaders are of tubing and are hinged to the main Vees, thus allowing a certain amount of flexibility. Both spreaders and axle are encased in a metal streamline box. Special rubber cord is used for shock absorbing and this is protected from wear against the wheels or axle guide by half spools. It is strapped to an aluminum saddle at the bottom of the Vee and so designed is this latter that it prevents the cord from sliding under any conditions from the original positions. Both front and rear bays of the Vees are braced by heavy cables.

Tail and Wing Tip Skids.—The tail skid is a large steel tube bent so as to allow plenty of swivel movement without interfering with the fuselage and thereby damaging same in case of a tail swipe. The skid is hinged to a swivel mounted in the bottom of the fuselage stern-post which latter extends down below the lower longerons for this purpose. Rubber cord such as is used in the main landing gear is likewise used in the skid. This is wrapped around the front end of the skid and is prevented from sliding by collars welded on to the latter. On the rear end is welded a large steel shoe.

Each lower wing end is also equipped with skids. These are of hickory and so shaped as to spring in case the wing should come in contact with the ground when landing.

Fuselage.—The fuselage was designed from a viewpoint of comfort and is large and spacious.

Four spruce longerons of heavy construction are used in conjunction with struts of the same material. Cable is used throughout for bracing. The front is wired only on the sides

and bottom However, four large plywood panels of spruce, cut out in the center, eliminate all internal cross wiring and thereby provide a clean clear cabin throughout. The sides are covered by three-ply veneer, composed of birch with white-wood core. The same material forms the top and bottom as well as the nose

On each side of the cabin are placed sixteen large wicker chairs upholstered with green leather, leaving an aisle of about 15 ins. Provision is made for eight folding seats (to be placed between each two corresponding seats) in the aisle. Thus, with the two pilot seats, gives a capacity of twenty six people. When not in use the folding seats are removed and placed in a cupboard incorporated in the rear end of the cabin.

Forward of the passenger seats and in the nose of the cabin are two pilot seats. Two sets of Dep controls are provided side by side, thus allowing the navigator or relief pilot to assume control without changing seats

Entrance is gained through a door on the left side of the cabin in the forward end The rear of the cabin is provided with a trap door and is used for fuselage inspection or repairs, as well as a rear exit.

All control cables are carried under the floor with the exception of the engine controls, which are carried overhead and along the sides to the engines

Under the pilot seat is placed a fire extinguisher, as is one on the rear end of the cabin. Between the two seats is a large air hand pump used for starting purposes only

The whole nose of the machine is practically windows composed of pyralin sheeting 1/8 in thick The side windows are of the same material and are of yellow hue, which prevents any discomfort which may be caused by the sun

Engines and Tanks.—Each wing carries an engine placed in a nacelle. These are equipped with separate gas systems operated from either seat as before mentioned The nacelles are composed of strong laminated ash longerons braced by large spruce struts, plywood bulkheads and cables. On the extreme nose is a radiator resting on a padded steel plate. This same plate carries the front ends of the longerons as well as the engine beds which are of laminated spruce and ash. Two heavy U-shaped panels come next with a channel steel tie beam over the first. The rear ends of the engine beds are bolted by fittings to a large cross-strut in line of the rear wing struts

Behind the engine are placed two large steel gas tanks, connected together and having a total capacity of 136 gals. A large triangular space is provided behind the gas tanks for tools or spares. The oil radiators have 12 gals. each and are placed directly under each engine, behind the radiators, where they will be allowed to cool.

Detachable aluminum hoods cover the sides, bottom and rear end of the top The engines are exposed overhead on the present flight, but covers are provided for this in case same are required A trap door allows entrance for the tools. These doors are also provided under the nacelles for inspection and oil drainage, while large louvres are placed in the side sections, allowing plenty of space for air circulation

STRUCTURAL CHARACTERISTICS

Overall length	48 ft 0 in
Overall heighth	18 ft 0 in
Wing section	U S A 5
Area of upper wings (with ailerons)	975 sq ft.
Area of lower wings (with ailerons)	832 sq ft.
Total wing area (with ailerons)	1767 sq. ft.
Span of upper and lower wings	91 ft 0 in
Chord of upper and lower wings	9 ft 10 in.
Aspect ratio of upper and lower wings	9 ft 25 in.
Gap	9 ft 4 in
Chord gap	0 974
Stagger	None
Decalage	None
Angle of incidence to propeller axis	3.5 deg
Heighth of propeller axis above ground with:	
1. Machine resting on ground	9 ft 0 in
2 Propeller axis in line of flight	9 ft 0 in
Angle between line from base of wheel to c g with a vertical line when machine is horizontal	18 deg
Angle between line joining wheel base and skid to a horizontal line	9 deg
Stabilizer setting to lower wing coord (see below)	0 deg
Stabilizer adjustment	— 2 to + 5 deg
Fin adjustment	None

AREAS OF CONTROL SURFACES

Areas of ailerons (upper & lower wings)	230 sq. ft.
Areas of Stabilizers	115 sq. ft.
Areas of Elevators	100 sq ft.
Areas of Fins	25 sq. ft.
Areas of Rudders	45 sq. ft.

WEIGHT SCHEDULES

Power Plant (complete)	2762 lb.
Fuel & Oil (272 gal. & 24 gal. oil)	2410 lb.
Passengers & Miscellaneous Equipment (26 passengers)	4992 lb.
Body (complete)	1880 lb.
Nacelles	418 lb.
Tail surfaces and bracing	325 lb.
Wing Structure	2180 lb.
Landing gear	383 lb.
Total	15323 lb.

The horizontal speed is given by the manufacturer as being 110 m.p.h. at ground level 88 m.p.h. at 6,000 ft and 90 m.p.h. at 10 000 ft.

The Loening Seaplane

THREE-QUARTER REAR VIEW OF THE LOENING HYDRO-MONOPLANE WHICH CLIMBED 18,500 FT ON SEPT. 29

National Balloon Race

In the first national balloon race held in this country since the war, open to all American pilots, the balloon Goodyear II, piloted by Ralph Upson, chief aero engineer for the Goodyear Tire & Rubber Co., of Akron, Ohio, with Ward T. Van Orman acting as aide, won the American championship.

The race was started from St. Louis, with ten balloons competing, all of which were of 80,000 cubic feet gas capacity and were inflated with illuminating gas The first balloon was let go at 6 p. m., the others following at intervals of five minutes.

The course of the winning balloon, Goodyear II, took it over Lake Michigan, Lake Huron, Georgian Bay, across Ontario and the northern part of Lake Champlain, finally landing at Dunham, Quebec, a few miles north of the Vermont State line, having covered an air line distance of 1050 sta. mi.

The victory was achieved through a combination of thoroughly modern equipment and scientific piloting The big balloon was constructed of two-ply rubberized fabric, spread with aluminum Mayor Kiel, of St. Louis, was on hand to bid the two Goodyear balloonists good bye and to wish them good luck.

The landing was made in the face of a tremendous storm, with only occasional jagged forks of lightning to indicate the height from the ground The last four hours in the air were covered in a wind of 60 m.p.h.

The outcome of this contest brings victory for the third time to Goodyear in the National race, Ralph Upson having won the 1913 event and R. A. D Preston the 1914 race. Both are eligible to enter the International Balloon race to be held in the United States in 1920 Both of these pilots proved to the world the supremacy of American pilots in the last International race held at Paris, France, in 1913, when in a wonderful flight from Paris to northern Scotland, they won the International championship in the American balloon, Goodyear, over a large field of crack balloonists from all parts of Europe.

Balloon men are expecting a big revival in balloon racing as a result of the race just held at St Louis. Thousands of young men have become pilots since America's entry into the war and have seen service in the air with the expeditionary forces. These men and their friends are quite likely to take an increased interest in ballooning in this country because of their service abroad.

Fahrig Anti-Friction Metal

The Best Bearing Metal on the Market
A Necessity for Aeroplane Service

Fahrig Metal Quality has become a standard for reliability. We specialize in this one tin-copper alloy which has superior anti-friction qualities and great durability and is always uniform.

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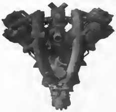

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- General driving shaft ball bearing container (upper)
- Intake header
- Intake header water outlet (angle)
- Intake header water outlet (double)
- Oil pump body (upper)
- Oil pump body (lower)
- Oil pump body (lower half cover)
- Oil pump pressure relief valve guide
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